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Advanced microscopy of multicomponent functional materials: The merit of utilizing routine electron microscopes

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The routine electron microscopes are still playing an important role in materials science and inorganic chemistry although significant progress has been made in microstructure characterization by applying Cs-corrected electron microscopy. Here I give several research cases.

First, based on electron beam induced deposition in a high-vacuum SEM using $Fe(CO)_5$, a cellular film of iron nanocrystals has been successfully fabricated through a detailed microscopy analysis. Second, an imaging strategy for surfaces is proposed that involves adjusting the contrast transfer function of TEM to either atomic details of individual basic structural units or to the supramolecular assembly of basic structural units of crystal. The imaging strategy can be applied to other issues involving structures with large unit cells (e.g., complex $MoVTeNbO_x$ catalyst) and does not require special high-end instrumentation. Third, a new phase-change mechanism was proposed by combining microstructure investigations of phase-change GeSbTe alloy with the thermodynamics analysis of system. Forth, an unusual martensitic transformation from HCP alpha-Ti to BCC beta-Ti twining induced by rapid heating was achieved in a popular Ti-6Al-4V alloy under an electropulsing, which agrees well with the phenomenological crystallographic theory of martensitic transformation.

The aforementioned methods and analysis can be extended to the emerging field of solid oxide fuel cell, and may contribute to revealing some new relevant physics/chemistry.

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